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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/551,233	04/17/2000	Katsuyoshi Matsuura	FUJ 99228 CIP	9686
7590 10/08/2004			EXAMINER	
William J Kubida Esq Hogan & Hartson LLP Suite 1500 1200 17th Street Denver, CO 80202			LEE, HSIEN MING	
			ART UNIT	PAPER NUMBER
			2823	
DATE MAILED: 10/08/2004				

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/551,233

Applicant(s)

MATSUURA ET AL.

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 27 September 2004.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 12 and 15-19 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 12 is/are allowed.
- 6) ☒ Claim(s) 15-19 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE
PRIMARY EXAMINER

Attachment(s)

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: _____

DETAILED ACTION

Remarks

1. Claims 12 and 15-19 are pending in the application.
2. Applicant's RCE filing is acknowledged.

Claim Objections

3. Claim 15 is objected to because of the following informalities: inconsistent terminology, i.e. "active device" (line 3) versus "active device element" (line 3). Appropriate correction is required.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. Claim 15 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

In amended claim 15, it recites "said active device including a ferroelectric **capacitor**" (lines 3-4) and "an insulation film provided to **cover** said active device" (lines 5-6) and "a lower electrode containing Pt provided **over** said insulation film" (line 8). (emphasis added)

If the insulation film were provided to **cover** the active device (lines 5-6), which includes the capacitor (lines 3-4), why the lower electrode of the capacitor would be **over** the insulation film (line 8) as well.

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It is well known that the lower electrode is located at the lower portion of the capacitor. When the insulation film covers the active device including the ferroelectric capacitor, it would also cover the lower electrode as well. In other word, it is impossible for the lower electrode being provided over the insulation film (refers to claim 15, line 8).

In Figs. 22J-22L of the instant application, it supports the examiner's assertion. The drawings illustrate that the insulation film 54 covers the capacitor 50/51/52A/53A, wherein 50 and 51 refers to the lower electrode. Obviously, the lower electrode 50/51 is **under** the insulation film 54, **not over** the insulation film 54, as recited in claim 15, line 8.

The examiner believes that the active device element recited in claim 15 *prior to* the amendment may refer to a CMOS device, including gate electrodes 44A and 44B, but not including the capacitor.

For the reasons given above, the foregoing limitations have not been treated in this Office Action.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 15-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cuchiaro et al. in view of Izuha et al. (US 6,060,735) and Chu et al. (US 6,287,637).

Cuchiaro et al., in Fig. 1 and related text, teach the claimed device, comprising:

- a substrate 102;

- an active device element 110 formed on a substrate 102 (Fig. 1);
- an insulation film 114 provided over said substrate 102 to cover said active device element 110 (Fig. 1);
- a ferroelectric capacitor comprising a lower electrode layer 116/120 containing Pt provided over said insulation film 114, wherein the lower electrode 116/120 comprises a *Ti layer 116* and a *conductor layer 120 (Pt)*;
- a PZT ferroelectric film 122, having a *perovskite structure*, provided on said lower electrode 120; and
- an upper electrode 124 provided on said PZT ferroelectric film 122 (Fig. 1).

Cuchiaro et al. do not teach that said PZT ferroelectric film 122 has a *columnar* microstructure extending from an interface between said lower electrode 120 and said PZT ferroelectric film 122 is in a direction substantially *perpendicular to* a principal surface of said lower electrode 120, said PZT ferroelectric film 122 generally has a *<111> orientation* extending continuously from a bottom surface of said PZT ferroelectric film 122 to a top surface of said PZT ferroelectric film 122 and consisting of *crystal grains* generally having said *<111> orientation* and a substantially *uniform* grain diameter of *less than about 200 nm*.

However, Izuha et al. (Figs. 1-7), in an analogous art, teach the claimed semiconductor device, comprising a semiconductor substrate 1; a lower electrode 4 provided over the semiconductor substrate 1; a ferroelectric PZT film 5 on said lower electrode 4 (Fig. 1), said ferroelectric PZT film 5 (col. 4, lines 52-53) having a *columnar* microstructure extending from an interface between said lower electrode 4 and said ferroelectric PZT film 5 (Fig. 4A) in a direction substantially *perpendicular to* a principal surface of said lower electrode 4 (col. 2, line

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57 through col.3, line 45), said ferroelectric film 5 is extending continuously from a bottom surface of said PZT ferroelectric film to a top surface of said PZT ferroelectric film and consisting of *crystal grains* having a generally *uniform* grain diameter of *less than about 200 nm*, i.e. ranging from 5 to 500 nm (col. 6, lines 52-53 and Fig.4A).

Therefore, one of ordinary skill in the art, at the time the invention was made, would have been motivated to provide the semiconductor device of Cuchiario et al. having a columnar microstructure extending from the interface between the lower electrode and the ferroelectric film in a direction substantially perpendicular to the principal surface of said lower electrode, as taught by Izuha et al., since Cuchiario et al., and Izuha et al. have similar structure including a laminate film of the lower electrode, the ferroelectric dielectric and the upper electrode disposed in the order; and with the structure of Cuchiario et al., and Izuha et al. it would provide a lattice-matching structure, which, in turn, would reduce current leakage in the device (abstract, Izuha et al.).

Still, Cuchiario et al in view of Izuha et al. do not teach that the PZT ferroelectric film generally has a $\langle 111 \rangle$ orientation and consists of crystal grains generally has the $\langle 111 \rangle$ orientation.

Chu et al., however, teach the claimed ferroelectric PZT film and crystal grains with the $\langle 111 \rangle$ orientation in a semiconductor device, which would improve electrical characteristics of the device (col. 3, lines 47-55).

Therefore, one of ordinary skill in the art, at the time the invention was made, would have been motivated to provide the semiconductor device of Cuchiario et al. in view of Izuha et al. having ferroelectric PZT film with a $\langle 111 \rangle$ orientation and consisting crystal grains with the

<111> orientation, as taught by Chu et al., since by this manner it would provide a semiconductor device having better electrical properties.

Allowable Subject Matter

8. Claim 12 is allowed.

9. The following is a statement of reasons for the indication of allowable subject matter:

The closest prior art of record, Cuchiario et al. (US 6,165,802), teach a method of fabricating a semiconductor device having a ferroelectric capacitor 118, as stated previously.

In contrast, Cuchiario et al. do not teach crystallizing the ferroelectric film under a reduced total pressure in the range between 1 Torr and 40 Torr such that peeling of the ferroelectric film is substantially reduced.

Chu et al. to US 6,287,637 teach crystallizing the PZT ferroelectric film under a reduced oxygen partial pressure atmosphere (col. 6, lines 41-47) in the range of 10^{-4} to 100 Torr (col. 7, line 28), wherein the reduced oxygen pressure is a partial not a total pressure, i.e. the ambient for the crystallizing comprises *oxygen and argon, not pure oxygen*. Although Chu et al. do suggest that crystallizing the ferroelectric film can be performed in a pure oxygen ambient, Chu et al. do not teach the reduced total pressure of oxygen is in the range between 1 Torr and 40 Torr.

Response to Arguments

10. Applicant's arguments filed 9/27/04 have been fully considered but they are not persuasive.

Applicants' arguments is on the ground that Izuha et al do not teach substantially uniform grain size. In this regard, applicant asserted that ' the usage of the plural form of "sizes" in Izuha et al, referenced above, merely means that the lateral size of the crystal grain in the dielectric

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film and the lateral size of a corresponding crystal grain in the upper electrode are the same.'

(last paragraph, page 4) Applicant further maintained that " the columnar grain structure is the same in layers 4, 5 and 6 but that the exact dimensions d1, d2 and d3 of the columnar grains can vary." (second paragraph, page 5)

In response to the arguments, Izuha et al teach that the **size** and crystal orientation of columnar grains A **succeed** from the lower electrode 4 to the upper electrode 6 (col. 6, lines 6-8). Izuha et al. further teach that " [t]he polycrystalline film was having columnar grains A of which the **sizes** of the dielectric thin film 5 and the upper electrodes 6 were the **same** in the direction of the substrate surface **corresponding to the size** of the crystal grains of the lower electrodes 4 and the crystal orientations thereof were the same." (col. 11, lines 35-41) (Emphasis added).

If the grain sizes in layers 4, 5 and 6 were all the same, it would indicate all grain diameter in layers 4, 5 and 6 are uniform. This is contrary to the applicant's assertion that "there are no words to the effect that $d1=d2=d3$, or that such dimensions are substantially uniform in Izuha et al.. (third paragraph, page 5). This factual evidence is given by words in Izuha et al. not merely illustrated by Figure 4, as asserted by the applicant. (page 6).

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on Tuesday-Thursday (8:00 ~ 6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-Ming Lee
Primary Examiner
Art Unit 2823

Oct. 7, 2004

HSIEN-MING LEE
PRIMARY EXAMINER

10/7/2004
